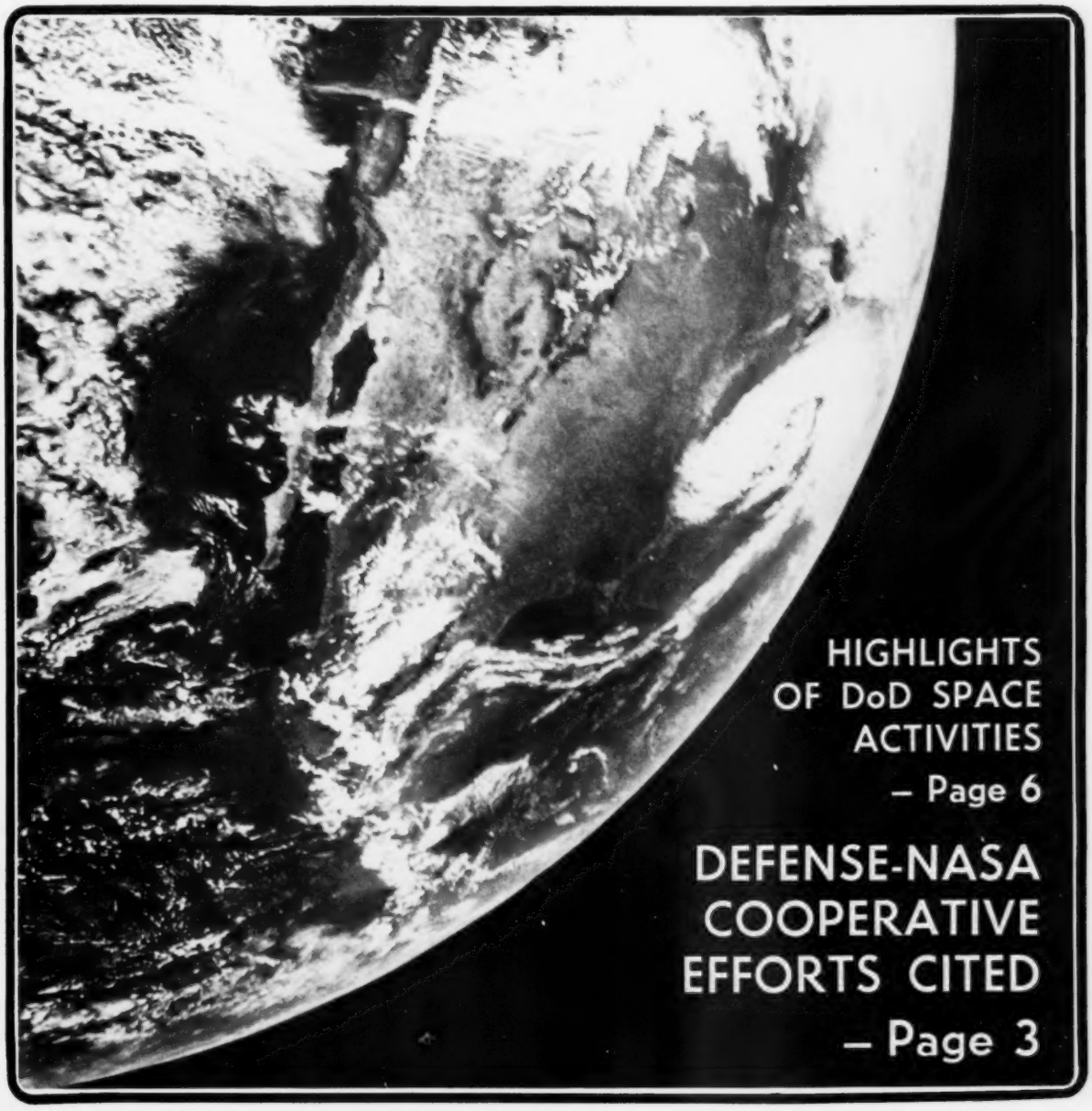
COMMANDER'S DIGEST

VOL. 14, NO. 1/JULY 5, 1973

DEFENSE SPACE PROGRAM



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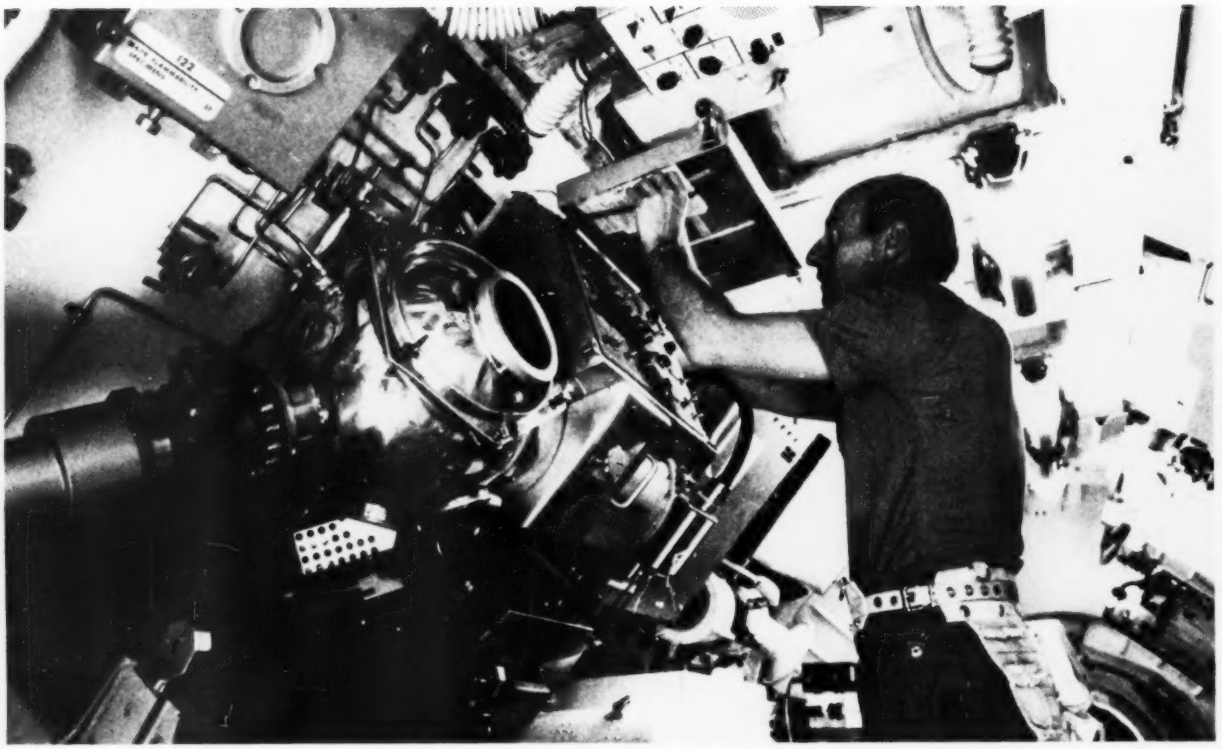


Astronaut Charles Conrad Jr., commander of the first Skylab mission, rehearses in a NASA trainer mockup. (NASA Photo)

Congress Hears About Space

DoD Space Program Detailed, Project-by-Project

In the beginning of each Congressional session, Department of Defense officials are called upon by the various Congressional Committees to testify on a variety of subjects. The officials are many, the subjects varied, but the issue is the same —spell out the details and programs where dollars are scheduled to go.

During the Fiscal Year (FY) 1974 hearings, the Department of Defense activities in space and aeronautics were explained by Dr. John S. Foster, Jr., then Director of Defense Research and Engineering, before the Senate Committee on Aeronautical and Space Sciences.

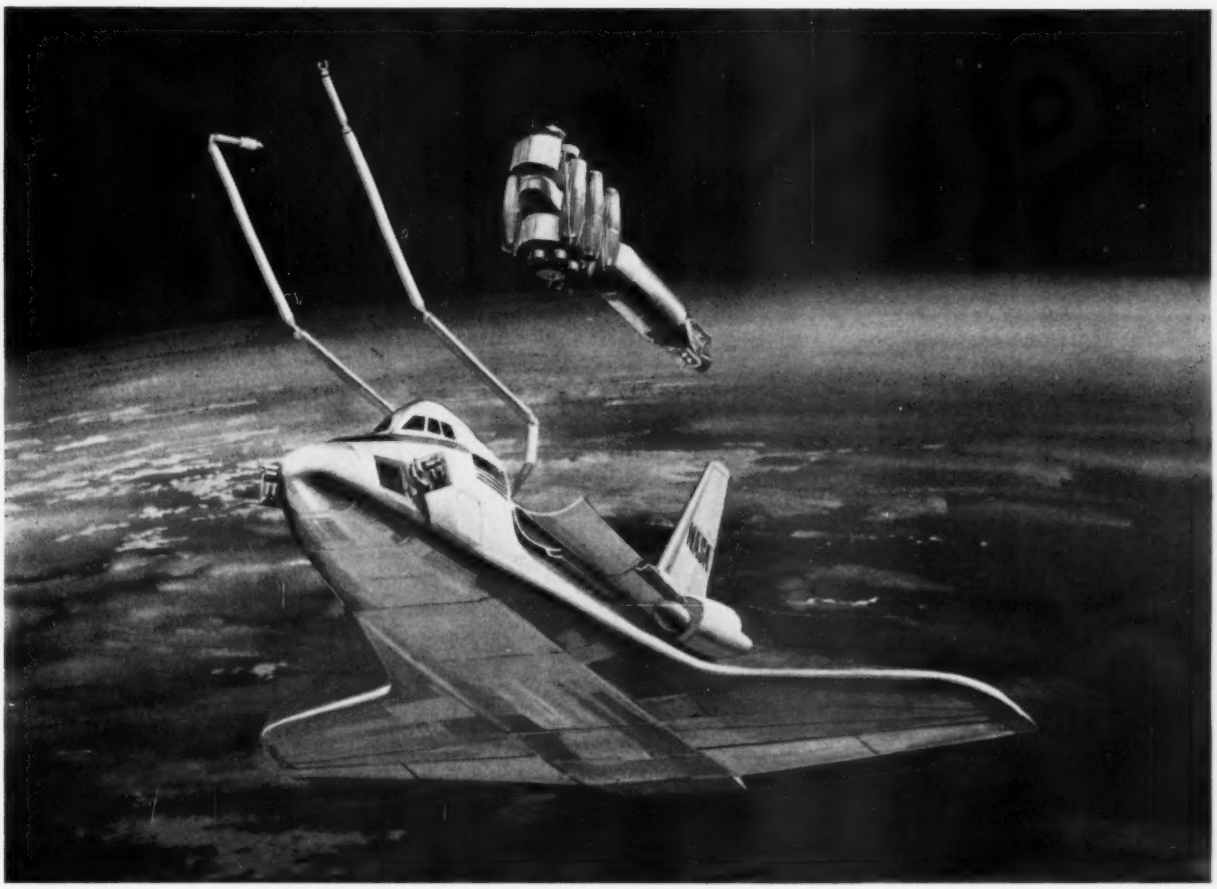
This issue of COMMANDERS DIGEST explains the most significant aspects of the DoD space program.

DoD space activity last year, as expressed in terms of the total numbers of launches attempted (16) and successful (14), fell to the lowest level since 1960. Highlights of the successes were the placement of another early warning satellite in stationary orbit to warn of Submarine Launched Ballistic Missile (SLBM) attack and the launch of an improved Navy navigation satellite. This low mark in space launches coincided with a minimum funding level in FY 1972. The FY 1973 budget reflected an increased level of space effort that is continued in the FY 1974 budget request now before the Congress. For FY 1974 DoD is seeking increased funding for mission-oriented systems, supporting research and development, and other support activities.

—Dr. John S. Foster, Jr.
Director
Defense Research and Engineering
before the Senate Committee on
Aeronautical and Space Sciences,
The 93rd Congress, First Session

Joint Space Effort

DoD-NASA 'Cooperative' Structure



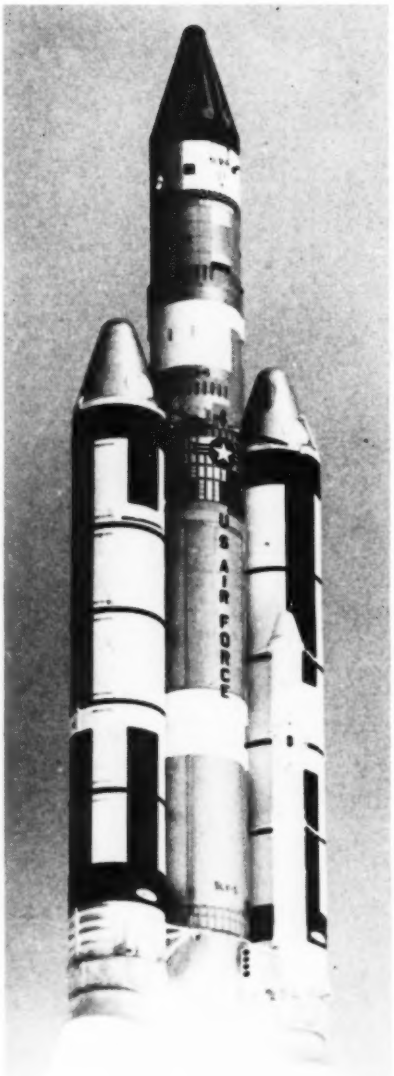
Artist's concept of a shuttle orbiter, with manipulator arms extended, preparing to recover an orbiting satellite. (NASA Photo)

The Aeronautics and Astronautics Coordinating Board (AACB) is the formal authoritative mechanism by which DoD and NASA programs and activities of common interest in space and aeronautics are coordinated. This coordination is accomplished through the AACB's five panels. Because the board is composed of high officials of the two agencies, it does much to insure close working relationships between NASA and the DoD at management levels, as well as day-to-day coordination of the most direct kind between people actually working on the projects involved.

Large New Aeronautical Facilities

As a result of studies on future national needs in aeronautics, the AACB has identified, and is supporting, three major facilities—the Aeropropulsion System Test Facility, the High Reynolds Number Tunnel, and the Full-Scale Subsonic Tunnel. As pointed out last year, further studies are necessary to provide detailed designs and firm-cost estimates that will support the acquisition of the facilities and fully identify their contributions to future civil and military aeronautical programs.

The Aeropropulsion System Test Facility will enable the testing of current engines in extreme operating conditions and will accommodate much larger engines that are proposed. The High Reynolds Number Tunnel can be used to test aerodynamic shapes at transonic speeds. Engineering design of these two facilities, to be located at the Air Force Arnold



LIFT-OFF—An Air Force Titan III-C booster makes the first of a series of launches to establish the first military satellite communications system. (U.S. Air Force Photo)

Engineering Development Center, has been started. In the Full-Scale Subsonic Tunnel, it will be possible to test full-scale short takeoff and landing (STOL) and vertical takeoff and landing (VTOL) aircraft. This tunnel, to be located at one of the NASA centers, is in the preliminary configuration-design phase.

NASA-DoD Studies in Aeronautical Technology

Last spring, the Aeronautics Panel undertook a study to insure that the Government's aeronautical research and technology activities were fully responsive to our military needs and to identify critical areas and promising technical opportunities for enhancing future military aeronautical capabilities. Subpanels examined technological areas applicable to rotorcraft, high-performance VTOL aircraft, supersonic aircraft, highly maneuvering aircraft, hypersonic aircraft, and flight simulation.

The study uncovered areas of technology that were not getting adequate attention and identified others that require greater emphasis. It pointed out program activities that appear to offer the greatest potential return on investment and the greatest range of application —at the same time, taking into consideration the practicality of resources. The AACB proposes that the Services and NASA consider the recommendations of the study in the planning and conduct of their respective aeronautical-technology programs.

National Launch Vehicles Program

The AACB has approved a joint policy statement concerning DoD-NASA coordination of the National Launch Vehicles Program that was drafted by its Manned Space Flight and Launch Vehicles (MSFLV) Panel. An updating of the DoD-NASA letter of understanding dated February 23, 1961, the joint policy statement reiterates the policy of not proliferating the current family of launch vehicles. Moreover, it requires that joint analyses be made of the many complex factors that must be considered in launch-vehicle developments and modifications and in assigning payloads to launch vehicles, as well as ways in which these decisions affect the total cost of launching payloads over a period of several years.

This policy was observed in selecting the NASA Atlas/Centaur vehicle to launch the Navy's Fleet SATCOM payload. Prior to the Navy's final commitment to this launch vehicle, the MSFLV Panel reviewed and analyzed the factors involved and obtained NASA's concurrence. Recently NASA outlined the conditions under which domestic users of communications satellites might obtain an uprated launch vehicle to meet their needs. NASA's position has been coordinated with the Air Force, and any resulting vehicle modifications would be evaluated by the MSFLV Panel in accordance with the joint policy.

Cost Reduction

The Board devoted two meetings to the subject of reducing the cost of future aeronautical and space systems. All of its panels participated. The MSFLV Panel identified the Space Shuttle program as the most productive area for joint effort. The Space Flight Ground Environment Panel identified other areas or items as offering possible improvements in cost reduction or avoidance—large computer systems in the Apollo net, minicomputers, techniques for increasing network data rates, contract requirements for documentation, and consolidation of facilities and services. The other panels have explored ideas, concepts and joint programs in their areas of interest and will select specific items for further effort. Prime candidates are component commonality and modernization, simplification of documentation, and simulation techniques. Learning how to get more for our money and searching for new ways to improve cost-effectiveness will be continuing projects of the AACB.

Facilities Coordination

Every year, DoD and NASA make a detailed technical examination of the facility projects proposed by each agency for the next fiscal year; the object is to eliminate unwarranted duplication and insure that these facilities are used to the maximum extent. The FY 1974 program review spanned a period of 8 months, ending in February 1973.

The initial Air Force program consisted of 52 projects estimated to cost $57.6 million. As a result of this facility review and the normal budget review, the Air Force program was reduced to 14 projects estimated to cost $12.9 million, a reduction by about 77.5 percent. The total DoD facilities program, as presented in the President's Budget, includes 57 projects estimated to cost $67.7 million, while the final NASA program includes 15 projects totaling $112 million, reduced from a preliminary estimate of $148.6 million.

WINGLESS AIRCRAFT—Three manned lifting bodies being tested by NASA as possible space shuttle prototypes include (from left): the X-24, M-2 and HL-10. (NASA Photo)

Space Shuttle

Over the past year, DoD and NASA have worked closely in their respective roles—NASA as the Space Shuttle developer and the DoD as an important future user of the Shuttle. DoD continues to strongly support this development.

DoD efforts relating to the Shuttle are being expanded in several areas. First, we are drafting a program memorandum covering DoD's use of the Space Shuttle and will coordinate it with NASA. The memorandum will include a plan with several options for DoD's early entry into the Shuttle program, taking into account NASA's schedules and development progress; it will identify key DoD planning milestones and will treat funding and management issues.

We are placing more emphasis on new concepts of payload design and operation. Past studies have shown that such new concepts are essential to achieving the Shuttle's full potential for more effective, less costly space operations.

Our coordination and planning have these goals:

- Insure that NASA knows and understands DoD needs so that the Space Shuttle, as developed, will be of maximum utility to us;
- Provide data essential to integrated planning and to the support of decisions leading to our future use of the Shuttle;
- Fully explore ways we can benefit most from the Shuttle's unique capabilities; and
- Coordinate with NASA our Shuttle-related activities, with a view to the best possible use of resources available to both agencies.

We have established a DoD Shuttle-User Committee to serve as a focal point for our broad and varied interests in the future military use of space. The committee, under Air Force chairmanship, includes representatives of the other Military Departments and the Joint Chiefs of Staff; NASA will be invited to provide an observer. This committee is very important to our DoD planning, for it will examine ways by which our future military operations can be improved by the flexible and effective access to space that the Shuttle offers. It will provide guidance for our ongoing studies of payloads and missions, will explore in some detail the transition from launching DoD payloads with expendable vehicles to the use of the Shuttle, and possibly will identify experimental DoD payloads to be carried on Shuttle R&D flights for NASA.

Two main issues relating to the use of the Shuttle now confront DoD: 1) How soon should DoD plan for the Vandenberg facility and the use of the Shuttle for essentially all of our payloads? 2) What kind of reusable upper stage should be developed to deliver payloads to orbits higher than the Shuttle can reach? And which agency—DoD or NASA—should fund its development?

We believe that the measures we have taken and are planning—studies of payload design and operating concepts, continued coordination with NASA, program-memorandum planning, and the activities of the DoD Shuttle-User Committee—will do much to clarify these issues in FY 1974. DoD has a strong interest in the resolution of the upper-stage issue because over half of our payloads must be delivered to orbits higher than the Shuttle alone can achieve. We intend to work with NASA to arrive at a recommendation this year on which of our two agencies should undertake to develop the required upper stage.

Because we anticipate that the Shuttle will play a key supporting role in our military space operations in the 1980s and 1990s, DoD recommends that the Congress continue to provide the necessary support for the Shuttle program.

DoD Support of NASA

DoD continues to support NASA in various areas. Defense resources committed in support of the Apollo 17 mission included three ships, 43 aircraft and nearly 4,000 people. With the successful completion of the last Apollo flight, the level of this support has declined.

In FY 1972, NASA reimbursed DoD a total of approximately $83.5 million, [an amount] less than $87.6 million for FY 1971. Of this amount, $11.8 million went to the Army, $21.3 million to the Navy, $45.1 million to the Air Force, and $5.3 million to Defense Agencies.

Other Coordination Activities

In 1972, the DoD technology base in the electronic sciences was singled out for special review for two reasons:

- It is one of the fastest moving fields of today, and
- Because of its basic character, it is of interest to many diverse organizations.

Through NASA's participation, the review became more comprehensive, and it was possible to eliminate unnecessary duplication and overlapping of work in this area by the two agencies.

NASA is now represented in the deliberations of the DoD Advisory Group on Electron Devices, which considers proposed programs in the electronic sciences.

DoD Program, NASA-DoD Cooperation, Soviet Efforts

The DoD's Fiscal Year (FY) 1974 budget request for its space program totals $1,827.4 million, as compared to $1,622.6 million in FY 1973. The table on this page provides a funding breakdown over the fiscal years 1971-1974.

The major portion of the $205-million increase over the FY 1973 space budget is to:

- **Reduce the vulnerability of the Transit navigation system;**
- **Produce spacecraft and space boosters for both the Fleet Satellite Communications (Fleet SATCOM) System and the Defense Satellite Communications System (DSCS);**
- **Cover R&D costs in the areas of early warning and general support; and**
- **Increase supporting R&D effort for the space test program and for advanced surveillance technology in the area of earth-limb-measurement satellites and for a joint-Service navigation satellite experiment.**

We have reduced FY 1974 funding in several areas, the major reductions being in the procurement of early warning satellites and boosters.

NAVIGATION SYSTEM—The Transit navigation satellite, here in an artist's illustration, will furnish signals for the Navy's worldwide, all-weather navigation system. (U.S. Navy Photo)

Mission-Oriented Space Systems

Position-Fixing and Navigation. The conduct of military operations requires that the forces involved know their position, their velocity and their direction. These position-fixing and navigation requirements are now met by a variety of methods and equipment, including Loran and Omega radio systems, the Navy Navigation Satellite System, inertial guidance equipment, and navigation radar. Increases in our forces' mobility and in the sophistication and accuracy of our weapons create the requirement to improve our position-fixing and navigation capabilities. We are therefore examining and testing a number of new navigation concepts and systems.

Among the concepts under consideration, navigation satellites offer the potential of attaining a continuous, worldwide, high-accuracy capability that could satisfy many ground, sea, airborne and space applications, including 1) mapping and charting; 2) navigation and position-fixing; and 3) air-traffic control. We are supporting a coordinated, multi-Service program to study navigation-satellite system configurations and to test appropriate receiver technology and experimental components. A major joint-Service navigation space experiment to test and demonstrate satellite navigation

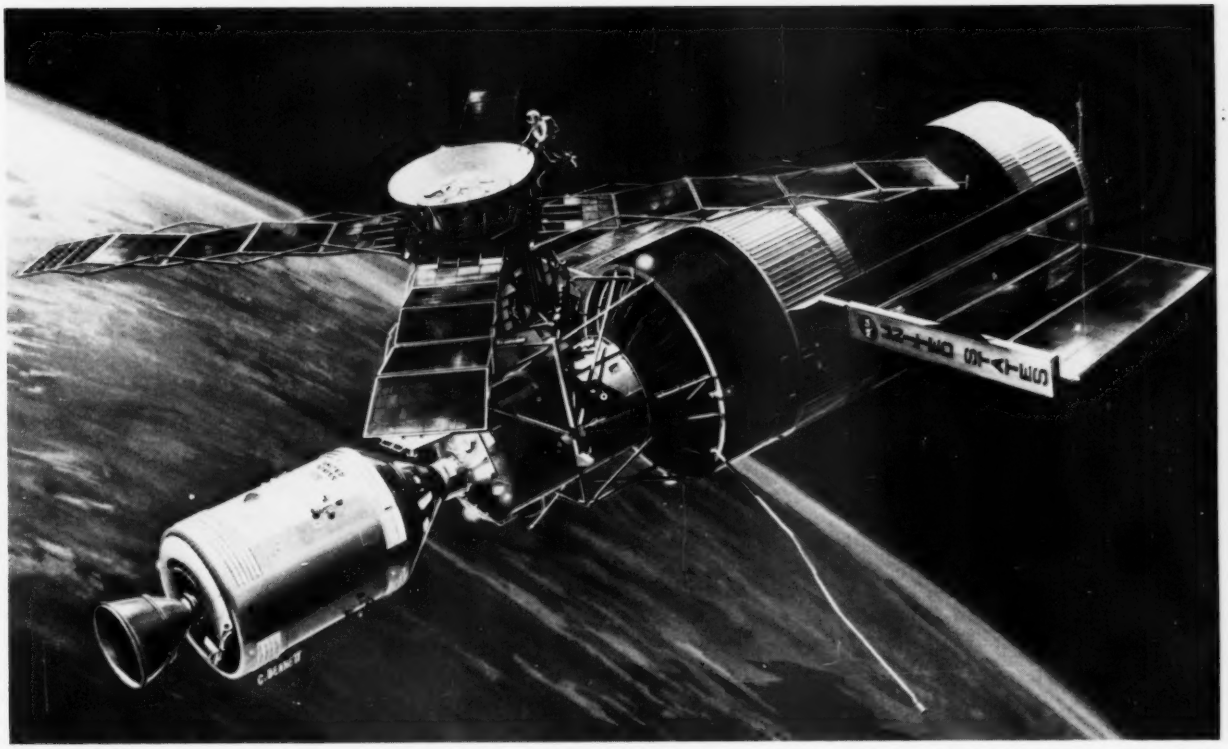
DOD SPACE AND SPACE-RELATED PROGRAMS
($ in millions)

Program	1971	1972	1973	1974
Navigation	7.4	6.5	7.8	12.9
Communications	84.6	54.2	161.4	240.2
Geodesy	5.8	5.8	4.9	5.5
Defense	3.9	3.4	3.4	3.4
Vehicle and Engine Development	46.0	36.2	30.6	34.1
Space Ground Support*	150.5	152.3	151.7	161.8
Supporting R&D**	84.6	118.0	120.5	146.0
General Support***	863.0	801.7	865.7	977.1
Miscellaneous	266.5	228.4	276.6	246.4
	1,512.3	1,406.5	1,622.6	1,827.4

*Includes range support, instrumentation, ground-based satellite detection, tracking and control.

**Includes basic and applied research.

***Includes activities of DoD laboratories and research centers, as well as general operational support.



Components of the Skylab—from left, command-service module, Apollo Telescope Mount, multiple docking adapter, airlock and workshop. (NASA Photo)

technology and capability is planned for the 1977-79 period. It is intended to evaluate the alternatives in system design, cost and operational value in order to define the optimum system to meet the navigation requirements of all the Military Services in the 1980s.

In FY 1973, an Air Force satellite-system simulation facility was placed in operation at the White Sands Missile Range. Using properly arranged ground transmitters, this facility is testing both space-segment concepts and the performance of prototype receivers. By late FY 1974, we will launch an experimental satellite that will interact with the simulation facility to confirm the effects of space propagation phenomena on various techniques for navigation signal modulation.

The Navy is improving the operational survivability and usefulness of Transit, the proven Navy Navigation Satellite System, pending the deployment of a more advanced global satellite navigation system. The first experimental navigation satellite in the improvement program was launched in September 1972. A decision regarding other proposed improvements is expected by June 1973.

To improve coordination of these and related activities, a Defense Navigation Planning Group (DNPG) was formed in January 1973. DNPG membership includes key representatives from offices in the Office of the Secretary of Defense (OSD) and the Departments most concerned with area navigation and related fields. Observer representatives from civil agencies—the Federal Aviation Administration, National Aeronautics and Space Administration and the Maritime Administration—will be invited as appropriate to assist the DNPG in resolving issues of joint civil and military concern.

Satellite Communications

Our experience with satellite communications has demonstrated that such systems can satisfy many military requirements for reliable, survivable, secure, and cost-effective telecommunications. **It is almost obvious that satellites are the ideal—if not often the only—solution to problems of communicating with highly mobile forces deployed worldwide.** And we must not forget that satellites, if properly used, provide the sorely needed

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Cover Photo courtesy of NASA.

RECOVERY OPERATION—Helicopter crews and frogmen from the carrier USS Ticonderoga work to recover the re-entry capsule and astronauts of the Apollo 17 moon mission shortly after splashdown. (NASA Photo)

geographically independent alternate to large, fixed ground installations. We are moving to reach these goals by developing some satellite communications to provide complementary services—Defense Satellite Communications System, Fleet Satellite Communications, and Air Force Satellite Communications.

The initial DSCS satellites are still providing secure communications in support of critical command, control, intelligence and warning needs. These small nonsynchronous satellites, limited in capability, have greatly exceeded their design life and are scheduled to turn off automatically by late 1974. Fourteen of the original 26 are still operational, seven more having failed during 1972.

To replace these satellites, a new DSCS Phase II satellite, that has about 10 times the communications capability of the initial satellites and will provide a flexible, high-capacity wideband transmission system, has been developed. Two of them were launched in November 1971. One is functioning in a degraded manner, while problems with the other require the use of the lower quality initial DSCS satellites in its stead until later this year, when a modified Phase II satellite from the second launch is scheduled to become available.

The Fleet Satellite Communications (SATCOM) System, whose development began in 1971, is intended to provide an improved global communication system for the Navy and also to satisfy Air Force requirements for strategic aircraft communications. Operating in the military UHF band, the Fleet SATCOM will be tailored to the characteristics of mobile users, especially to the size of the antenna they can accommodate. This system is a major step in modernizing Navy communications and will relieve the Navy of its almost total dependence on high-frequency (HF) radio transmissions, ultimately reducing the need for many HF ground stations overseas.

Survivable Satellite Communications

The survivability of reliable communications for the command and control of our strategic nuclear forces is of paramount importance to the credibility of our deterrent. For this reason, we are engaged in the development of new communications techniques and systems, including some that are space based, to improve the survivability of our strategic communications against nuclear and electronic attack.

The Air Force is developing the technology and components needed for the deployment of a survivable satellite communications system. Two experimental satellites, called LES 8 and 9, are scheduled for launch in September 1974 to

demonstrate and validate the necessary technology.

We are investigating promising means of ensuring the survivability and protection of satellite communications.

Geodetic Satellite Program

On January 1, 1972, management responsibility for all DoD geodetic and gravimetric programs, including this DoD Geodetic Satellite Program, was transferred from the Defense Intelligence Agency (DIA) to the newly established Defense Mapping Agency (DMA).

After the observational phase of the five-year Geodetic Satellite Program was completed in mid-1970, DoD adopted the Doppler system as the primary method of measurement by geodetic satellites. Programs utilizing Doppler receivers (geoceivers and similar equipment) are continuing with a view to improving geodetic and gravimetric parameters and related DoD requirements. This support consists principally of improving gravity and atmospheric models; establishing basic geodetic control of point-positioning, data-base preparation; and compiling maps and charts.

The 14 semipermanent Doppler stations deployed throughout the world continue to work toward upgrading the Doppler ephemeris for acquiring additional gravitational and positioning data. In the past year, DoD, using mobile Doppler equipment, established more than 100 precise geodetic positions throughout the world.

Geoceivers utilize the Doppler transmissions from the Navy Transit satellites and other Doppler-equipped satellites in determining geodetic and geophysical parameters.

Early Warning Satellites

Operational early warning satellites are in geostationary orbits to give warning of Intercontinental Ballistic Missile (ICBM) or Fractional Orbiting Bombardment System (FOBS) attack and to warn of attack on CONUS by submarine-launched ballistic missiles (SLBMs).

In 1974, we intend to improve the reliability of our satellites. Operational experience with components and subassemblies has helped us to identify those that have a major effect on satellite lifetime. By using new, proven technology to replace or redesign these troublesome components, we can increase reliability and, at the same time, reduce weight and power requirements.

Meteorology

The importance of meteorological data from satellites in the effective and efficient conduct of military operations has been firmly established, and new applications continue to appear as the scope and quality of meteorological-satellite data improve.

DoD relies on the National Oceanic Atmospheric Administration (NOAA)-NASA meteorological-satellite systems for some of its meteorological data needs, and DoD requirements are considered by NOAA and NASA in planning and developing these systems.

A joint DoD-Department of Commerce study is under way to determine the most cost-effective method of satisfying civil and military requirements in the 1977-81 period.

During the past year, the measurement of vertical profiles of atmospheric temperature from satellites was inaugurated on an operational basis. The use of this technique will provide for the first time an adequate global distribution of upper-air temperature data and the potential for improving and expanding the capabilities of civil and military weather services.

Ocean-Surveillance

During FY 1972, we initiated several programs to achieve major near-term improvements in our surface ocean-surveillance capabilities, and we also intensified efforts in several other programs whose objectives are to satisfy longer term needs in ocean surveillance. These actions comprised part of a large effort directed toward meeting the threat posed by the increased size and capabilities of the Soviet Navy.

These programs, carried under supporting Research and Development (R&D), were continued in FY 1973; the major RDT&E expenditures were on those programs that provide our tactical naval commanders with information critical to their defense against the surface threat.

Launch Vehicle Development

There were nine successful launches of Titan III space launch vehicles during Calendar Year (CY) 1972, including five Titan IIIB/Agena combinations, three Titan IIID launches and one Titan IIIC launch.

NASA will use the Titan IIIC and the Titan III/Centaur for launching some of its payloads beginning in 1974. The Titan III configuration, when used with the Centaur, has been designated the Titan IIIE. The E version is identical to the Titan IIID except that its electrical and mechanical interfaces are modified to match the Centaur and it is controlled by the Centaur guidance system.

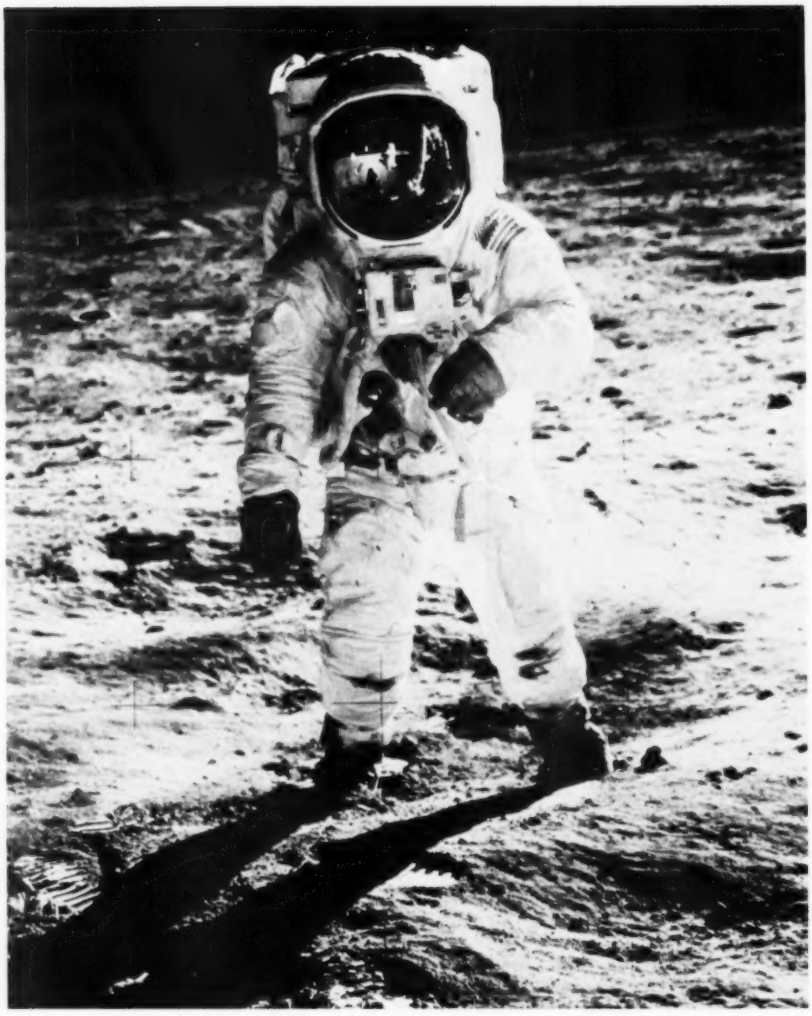
Our Titan III development program is essentially complete, but we will continue to make changes dictated by experience to assure high reliability, to minimize cost, and to provide modifications to meet firm payload needs. Development effort in advanced space engine work is also minimal, concentrating on continued exploratory development of a small liquid-rocket program to develop and demonstrate advanced technology applicable to high-performance, space-maneuvering reusable vehicles, and improved attitude-control systems.

We are continuing to fund studies to insure that the Space Shuttle system being developed by NASA will be of maximum utility to DoD. In addition, we plan to initiate payload studies to develop new design, operating, and mission concepts for lower cost space activities when the Space Shuttle is operational.

Test and Evaluation

Last year DoD initiated a series of changes to improve our overall weapon-systems acquisition process by revising and strengthening the application of test and evaluation (T&E). Some of last year's actions included the appointment of a Deputy Director for Test and Evaluation to act as the strong focal point at the OSD level for all T&E matters. Retired Army Lieutenant General Alfred D. Starbird, who has held this position for the past year, has been effectively revitalizing our test and evaluation practices to remedy deficiencies of the past and to meet the requirements of the future.

The primary duties of the Deputy Director for Test and Evaluation (DD-T&E) are to advise the Defense Systems



LUNAR MODULE PILOT—Astronaut Edwin E. Aldrin Jr., walks on the surface of the moon during Apollo 11 extravehicular activity. (NASA Photo by Astronaut Neil A. Armstrong)

Acquisition Review Council (DSARC) and the Deputy Secretary of Defense directly at each decision point on the advisability, from the test viewpoint, of proceeding to the next milestone; and to oversee for the Secretary of Defense DoD's range and test facility base, which is made up of our most important range and test centers.

Space Ground Support

Last year we reported that, under the direction of the DD(T&E), we would take steps to make our range and test facility base of 26 DoD installations more effective and efficient. DoD is pleased to report at this time that we have made progress toward this goal. For the past year, the Test Resources Review Committee (TRRC), chaired by the DD(T&E), has been in operation. It is composed of a representative from each Military Department, who constitutes the single focal point for ranges in that Service, and a representative from the Office of the Assistant Secretary of Defense (Installations and Logistics). The Committee has reviewed each of the 26 ranges for possible duplication of facilities; studied the ranges' land, water and air-space holdings; and conducted informative briefings with other Government agencies with a view to the possible joint use of the facilities.

In addition, a revised funding policy has been developed for the major ranges that will stress uniformity and should permit greater multi-Service use of the ranges. Conversion to this new policy will be fully accomplished in FY 1975. In spite of these steps, much remains to be done, and we will continue to rigorously improve the operation of our ranges and facilities.

Our relationship with NASA with respect to our test base continues to be excellent. Through the mechanism of the Space Flight Ground Environment Panel, under the Aeronautics and Astronautics Coordinating Board (AACB), there is continuing dialogue on mutual support and joint projects. Recently, a major review of concepts, approaches and point programs that could contribute to future savings or reductions in cost was completed. The results have been very encouraging; the Panel will continue to review these items and others that appear to promise cost-savings and will insure that a flow of information is maintained between agencies to exploit such possibilities.

Supporting Research and Development

We remain dedicated to the sustenance of a viable and dynamic technology base. We view this part of our R&D program as providing the means of improving the capability of present systems and reducing their cost, providing options for developing future systems and concepts, and guarding against technological surprise.

In the space and space-related areas, our approach is based on 1) the continuing study and analysis of military operational capabilities that could be provided, either optionally or uniquely, by a space system; and 2) the identification of key items of sensor or subsystem technology that could contribute to either a new or improved capability. Once such elements are identified, an applied research program is pursued to develop the subsystem or sensor, completely define its performance via laboratory tests, and where necessary confirm laboratory results by a space flight before

reaching the point of major system decisions.

For the fifth consecutive year, DoD is requesting increases in our supporting R&D funding—to $146.0 million in FY 1974, an increase of about 20 percent over FY 1973. These increases are concentrated in four areas:

- **Advanced surveillance technology—To fund the development of the earth-limb-measurements satellite. The mission of this satellite is to demonstrate the capabilities and limitations of sensors for future surveillance and defense systems.**
- **Space test program—To support the launch of the earth-limb-measurements satellite for the advanced surveillance technology program, which will obtain measurements of the earth's limb and the stars.**
- **Navigation satellites—To develop a joint-Service navigation satellite experiment to test and demonstrate technology and capabilities and to define the optimum Defense navigation system for the 1980s.**
- **Advanced space communications—To develop advanced optical space communications subsystems and techniques that will enhance the survivability of our satellites.**

Other areas in our applied space-technology programs include:

- **Wideband laser and millimeter-wave communications systems;**
- **Cryogenic coolers;**
- **Lighter weight, stronger materials for spacecraft;**
- **More precise attitude-reference and sensor-pointing devices;**
- **Lighter, more efficient, longer lived subsystems for space vehicles;**
- **Improved communications components and techniques; and**
- **More efficient low-thrust subsystems for spacecraft attitude control and station-keeping.**

Technical Superiority Remaining Edge

Soviet Space Activity Goes Up, America's Down

In analyzing Soviet space activities, the Department of Defense has compared United States and Soviet military and civil space efforts in terms of equivalent U.S. dollars and in terms of attempted space launches. In view of the inherent uncertainties in analyzing any Soviet effort, these two comparisons are useful indicators of the technological challenge in space. The tables on this page depict U.S. funding and space launches.

The Soviets continue to place emphasis on their space program. Their space effort has remained at a high, essentially constant level since about 1968, while the level of U.S. space activity has declined. Total Soviet effort in space continues to exceed ours by a large amount in terms of dollars expended and by a factor of over two times as many spacecraft launches as the United States. It is this kind of sustained effort that potentially threatens to erode our military technological lead in space. Despite the difference in launch rates, we believe that our current superior technology in this area and our engineering approach enable more progress per launch and that the disparity in progress is still not as great as might be indicated by launch rates.

U.S. CIVIL AND MILITARY SPACE EFFORTS
1963-1974*
($ in billions)

Year	Civil**	Military	Total
1963	3.9	1.5	5.4
1964	5.3	1.6	6.9
1965	5.4	1.6	7.0
1966	5.3	1.7	7.0
1967	5.1	1.6	6.7
1968	4.6	1.9	6.5
1969	4.0	2.0	6.0
1970	3.7	1.7	5.4
1971	3.1	1.5	4.6
1972	3.2	1.4	4.6
1973	3.1	1.7	4.8
1974	3.1	1.9	5.0

*In new obligational authority per fiscal year.
**Includes NASA's space effort and space activities of all other U.S. Government agencies—Atomic Energy Commission, Commerce, Interior, Agriculture, and National Science Foundation.

U.S. SPACE MISSIONS, 1972

Type of launch	Success	Failure	Total
Military	14	2	16
Communications	3	—	3
Meteorological	3	—	3
Lunar	—	—	—
Interplanetary	1	—	1
Manned	2	—	2
Developmental and Scientific	8	—	8*
	—	—	—
Totals	31	2	33

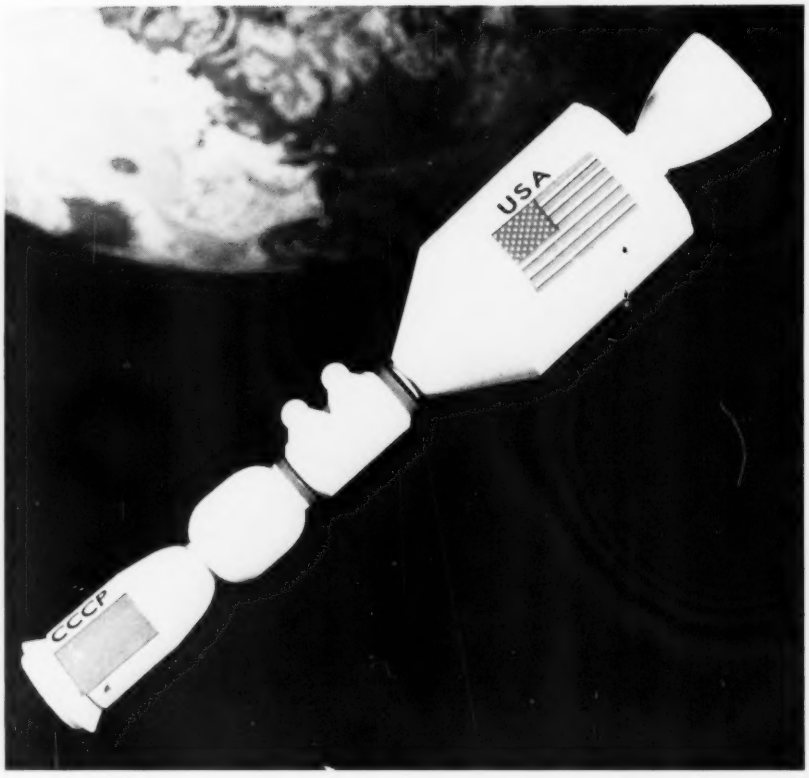
*Includes one payload launched by an Italian crew from the San Marcos launch site and four non-NASA payloads.

There were two major Soviet space achievements in 1972:

- **Luna 20 landed on the moon and returned a core sample of lunar soil weighing a few ounces to the Soviet Union; and,**
- **Separating from Venus 8, a descent capsule landed on Venus and transmitted data from the surface of that planet.**

Detailed Accomplishments

Communications: The Soviets maintain Molniya I satellites in active status,



TWO-NATION PROJECT—Models of the Soviet Union's Soyuz and U.S. Apollo spacecraft are shown as they would appear after docking in Earth orbit. (NASA Photo)

probably for multiple uses—relaying TV and voice communications and supporting space events. Molniya II now has a deployment to provide initial service to new Orbita II terminals. Communications service to the southern Soviet Union and Warsaw Pact nations will be improved with the launch of Statsionar, a synchronous equatorial communications satellite.

Orbita I terminals are dispersed throughout the Soviet Union to receive Molniya I transmissions. The Soviets have announced 20 sites in their initial Orbita II deployment, including three central stations, with the rest divided between Molniya II and Statsionar. These stations are probably still in development.

Meteorology: In 1972, the Soviets orbited three meteorological satellites, Meteors 11, 12 and 13, as compared to four in 1971. All Meteor satellite orbits are at 81-degree inclinations, and, since Meteor 10, an altitude of 500 nautical miles instead of 350 has been used. Primary information obtained is cloud distribution and temperature of the earth's surface and cloud tops. This information is used to forecast weather on a global basis and for specific areas. Three spacecraft are active, and it is apparently the Soviets' intent to maintain a net of at least three spacecraft positioned to give daytime coverage. Beginning with Meteor 10, an automatic picture-transmission (APT) capability was included in the system. The Meteor APT system is fully compatible with that used by U.S. meteorological satellites.

Man in Space: The Soviets did not orbit men in space in 1972—only the second year this has happened since 1961. It appears that current Soviet plans do not include manned Soyuz flights alone, but require an operating Salyut in orbit. Manned flights of Soyuz/Salyut are expected in 1973.

Lunar Program (Unmanned): Luna 20 was the only lunar launch attempt in 1972, while there were two attempts in 1971 and three in 1970. Luna 20's mission was very similar to Luna 16's in that it soft-landed on the moon's surface and returned a core sample of lunar soil, weighing a few ounces, to the Soviet Union. It is expected that missions involving soil-sample return and lunar-rover (Lunakhod 1) activity will be flown several more time before the Soviets attempt a manned exploration of the moon.

Interplanetary Probes: In March 1972, the Soviets launched a Venus probe, the Venus 8, which was successfully ejected. Arriving at Venus on July 22, 1972, Venus 8 separated a descent capsule which parachuted to the surface and transmitted data from the planet's surface. The Soviets were apparently successful in obtaining data on temperature, pressure and atmospheric density during the capsule's descent and after it landed. Since 1965, the Venus 8 was the first probe to succeed in getting detailed scientific data from the surface of Venus.

Soviet statements continue to reflect a strong interest in exploring Mars and Venus, though Mercury and the outer planets are occasionally mentioned. We expect that they will try to send probes to Mars and Venus during the launch windows in 1973 and 1975 and that they will attempt a flyby of Venus and Mercury during one of the yearly launch windows.

Scientific Research and Exploration: Five satellites were launched for scientific exploration and research. Three of them, Intercosmos 6, 7 and 8, were a continuation of joint studies with Czechoslovakia and East Germany on the effects of solar radiation on the upper atmosphere. The Prognoz program was initiated in 1972 with the launch of Prognoz 1, an experiment to study the interaction of solar radiation and the earth's magnetosphere. Prognoz 2 also carried a French experiment to search for neutrons radiated by the sun.

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